SCIENCE:

A WEEKLY RECORD OF SCIENTIFIC PROGRESS.

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PUBLISHED AT

229 BROADWAY, NEW YORK.

P. O. Box 3838.

SATURDAY, APRIL 30, 1881.

Since we last referred to Mr. Edison and his incandescent lamp, the subject has been advanced another step and the final stage of complete and unqualified success achieved; permission has been granted to the Edison Light Company, to place surface conducting wires under the streets of New York City, and in the course of the next two or three months, one large district of that city will be enjoying the full benefits of Mr. Edison's system of electrical illumination.

Taking a retrospective review of public utterances on this question during the last eighteen months, we now extend our condolence to a certain class of professed scientific experts who have maintained, from first to last, the impracticability of Edison's well-devised plans.

Never in the annals of scientific discovery has a grosser attempt been made to pervert the truth, and mislead public opinion.

As one instance among many, let us take up what is offered as a standard work of reference on this subject: "The Electric Light, its Production and Use, embodying plain directions for the working of galvanic batteries, electric lamps, dynamo-electric machines, etc.," by J. W. Urquhart, C. E., edited by F. C. Webb, M. I. C. E., M. S. T. E., London, 1880. Under the heading of "Edison's Lamps" we find "much interest has been taken in the sensational and often absurd announcements, concerning apparatus in course of perfection by Mr. T. A. Edison, of Menlo Park, New York (?), and it was in *some quarters* thought, that when he had set himself about the task of inventing an efficient subdivision of the electric light circuit, *something* would in all probability be done."

"There is little probability, however, that this lamp (the horse-shoe carbon) will prove constant. Burnt paper in various forms has been repeatedly tried before, and it is assuredly not constant, in the best possible vacuum obtainable." "We may indeed rest assured, that upon further reflection, Mr. Edison will abandon this imperfect burner." The same authors in speaking of the "Sawyer lamp," describe it as "the best incandescent lamp of this kind that has been invented."

Such being the teachings of an educational work, written by professed teachers on this subject, let them be compared with the actual results achieved, and the relative positions of the two men at this moment. Seldom has the irony of events demonstrated more forcibly that the honest work of a man is proof against the assaults of fraudulent or ignorant critics, and that the leveling influence of time always reveals the truth.

On the various attempts to imitate Edison's lamp we shall offer but a few words, for most practical inventors are usually plagued by men who endeavor to duplicate their successful inventions. If "imitation is the sincerest of flattery" we suppose Mr. Maxim is merely desirous of paying Edison a high compliment. Concerning Mr. Swan, of Newcastle, England, who professes to have perfected a horse-shoe carbon lamp, apparently identical to that of Mr. Edison's, we would draw attention to the significant fact, that in Messrs. Urquhart and Webb's work on the "Electric Light," dated as recently as April, 1880, and published in Mr. Swan's own country, not a single reference is made to the Swan electric lamp—in fact, his name does not occur in the book. This would appear to be conclusive evidence that neither Mr. Swan, nor his lamp, were known in England up to that date—unless he is included among the nameless crowd, spoken of by the authors, who had "repeatedly used burnt paper in various forms," and *who failed to secure constant results, even "in the best possible vacuum obtainable."*

CONGRESO INTERNACIONAL DE AMERICANISTAS.

We are in receipt of a pamphlet printed at Madrid, containing the official announcement of the above Congress, and instructions for those desirous of attending it. This is the fourth meeting of an International Congress for the discussion of American Archæology, and will take place on the 25th, 26th, 27th, and 28th of September next.

The object to be attained by this body is to contribute to the progress of Ethnographical, Linguistic and Historical researches relative to the two Americas, especially for the period prior to Christopher Columbus, and to bring together such persons as are interested in such studies.

Among the delegates from the United States we notice the names of Professor Spencer F. Baird, of Washington, Professor R. B. Anderson, of the University of Wisconsin; Professor J. Putnam Duncan, of the Academy of National Sciences, Davenport, Iowa, and Albert S. Gatschet, Esq., of 304 E street, N. W. Washington, D. C., to whose courtesy we are indebted for a copy of these official instructions.

Those desirous of attending this Congress, or of forwarding papers, should put themselves in communication with one of the above named gentlemen. Residents of New York City are welcome to read the prospectus at the office of "Science."

The Spanish railway authorities have consented to reduce the fares of those attending this Congress, and other concessions have been arranged. We direct the attention of those who have read early notices of this Congress to the fact that the first day of meeting has been changed from the 18th to the 22nd of September. This change has been made for the convenience of those who would attend two other International Congresses which meet at about the same time, one at Berlin and another at Venice.

THE UNITY OF NATURE.

By the Duke of Argyll.

VII.

ON THE MORAL CHARACTER OF MAN CONSIDERED IN THE LIGHT OF THE UNITY OF NATURE.

(*Continued*).

It breaks down the presumption that whatever is most savage is therefore probably the most ancient. And then, when we come to think of it, this idea, from being vague and general, rises into suggestions which are definite and specific. On the great fundamental subject of the relation of the sexes, conclusions not less important than those respecting cannibalism and infanticide are forced upon our conviction. We have seen that the cruel treatment of the female sex is almost universal among savages, and that it is entirely unknown among the lower animals. It is in the highest degree improbable and unnatural to suppose that this habit can have been primeval. But the same considerations carry us a great deal farther. They raise a presumption in favor of the latter origin of other habits and customs which are not confined to the savage state, but have prevailed, and do now prevail, among nations comparatively civilized. There can have been no polygamy when as yet there was only a single pair, or when there were several single pairs widely separated from each other. The presumption, if not the certainty, therefore is, that primeval Man must have been monogamous. It is a presumption supported by the general equality of the sexes in respect to the numbers born, with only just such an excess of the male sex as tends to maintain that equality against the greater risks to life arising out of manly pursuits and duties. Thus the facts of Nature point to polygamy as in all probability a departure from the habits of primeval times. Like considerations set aside, as in a still higher degree unnatural and improbable, the primeval rank of other customs of which the historians of human culture tell us, and probably tell us truly, that there are many surviving traces among the existing customs of men. Thus "marriage by capture" cannot have been primeval. It may be very ancient; but it cannot possibly have arisen until the family of Man had so multiplied and scattered, that it had become divided into tribes accustomed to act with violence towards each other. And then as regards a custom still more barbarous and savage, namely, that of polyandry, and that which is now euphemistically called "communal marriage," apart from the strong presumption in favor of primeval monogamy, they are stamped by many separate considerations as corruptions and as departures from primeval habits. In the first place, all such customs are fatally injurious to the propagation of the race. In the second place, they are unknown in the animal world. In the third place, their origin can be assigned, in many cases, if not with certainty at least with the highest probability, to one cause, and that is the previously-acquired habit of female infanticide. But as regards this last habit, besides the certainty that it cannot have been primeval, we know that it has often arisen from customs such as the exorbitant cost of marriage portions, which can only have grown up under long developed and highly artificial conditions of society.

But powerful as all these separate considerations are to raise at least adverse presumptions against the primeval rank of the worst and commonest characteristics of savage life, the force of these considerations is much increased when we find that they are closely connected together, and that they all lead up to the recognition of a principle and a law. That principle is no other than the principle of Development; that law is no other than the law of Evolution. It is a curious misunderstanding of what that law really is, to suppose that it leads only in one direction. It leads in every direction in which there is at work any one of the "potential energies" of Nature. Development is the growth of germs, and according to the nature of the germ so is the nature of the growth. The flowers and fruits which minister to the use of Man have each their own seed, and so have the briars and thorns which choke them. Evil has its germs as well as good, and the evolution of them is accompanied by effects to which it is impossible to assign a limit. Movement is the condition of all being, in moral as well as in material things. Just as one thing leads to another in knowledge and in virtue, so does one thing lead to another in ignorance and vice. Those gradual processes of change which arise out of action and reaction between the external condition and the internal nature of Man have an energy in them of infinite complexity and power. We stand here on the firm ground of observation and experience. In the shortest space of time, far within the limits even of a single life, we are accustomed to see such processes effectual both to elevate and degrade. The weak become weaker and the bad become worse. "To him that hath more is given, and from him that hath not is taken even that which he seemeth to have." And this law, in the region of character and of morals, is but the counterpart of the law which prevails in the physical regions of Nature, where also Development has its double aspect. It cannot bring one organism to the top without sinking another organism to the bottom. That vast variety of natural causes which have been grouped and almost personified under the phrase "Natural Selection," are causes which necessarily include both favorable and unfavorable conditions. Natural Rejection, therefore, is the inseparable correlative of Natural Selection. In the battle of life the the triumph of one individual, or of one species, is the result of causes which bring about the failure of another. But there is this great distinction between the lower animals and man,—that in their case failure involves death and complete extinction, whilst in his case it is compatible with prolonged survival. So far as mere existence is concerned, the almost infinite plasticity and adaptability of his nature enable him to accommodate himself to the hardest lot, and to the most unfavorable conditions. Man is the only animal whose possible distribution is not limited to narrow, or comparatively narrow, areas, in consequence of exclusive dependence upon particular conditions of climate and of productions. Some such conditions of a highly favorable kind may, and indeed must, have governed the selection of his birthplace and of his infancy. But when once born and fairly launched upon his course, it was in his nature to be able to prevail over all or over most of the limitations which are imposed upon the lower animals. But it is this very power of adaptation to unfavorable circumstances which involves of necessity the possibility of his development taking an equally unfavorable direction. If he can rise to any level, so also can he descend to any depth. It is not merely that faculties, for the exercise of which there is no call and no opportunity, remain dormant, but it is also, that if such faculties have already been exercised,

they may and often do become so stunted that nothing but the rudiments remain.

With such immense possibilities of change inherent in the nature of man, we have to consider the great element of Time. Strangely enough, it seems to be very commonly assumed that the establishment of a great antiquity for the human race has some natural, if not some necessary, connection with the theory that primeval Man stood on some level far lower even than any existing savage. And no doubt this connection would be a real one if it were true that during some long series of ages Development had not only been always working, but had always been working upwards. But if it be capable of working, and if it has been actually working, also in the opposite direction, then the element of time in its bearing upon conditions of modern savagery must have had a very different operation. For here it is to be remembered that the savage of the present day is as far removed in time from the common origin of our race as the man who now exhibits the highest type of moral and intellectual culture. Whether that time is represented by six thousand, or ten thousand, or a hundred thousand years, it is the same for both. If therefore the number of years since the origin of Man be taken as a multiplier in the processes of elevation, it must be taken equally as a multiplier in the processes of degradation. Not even on the theory which some hold, that the human species has spread from more than one centre of birth or of creation, can this conclusion be affected. For even on this hypothesis of separate origins, there is no reason whatever to suppose that the races which are now generally civilized are of more recent origin than those which are generally savage. Presumably, therefore, all the ages which have been at work in the development of civilization have been at work equally in the development of savagery. It is not possible in the case of savagery, any more than in the case of civilization, that all those ages have been without effect. Nor is it possible that the changes they have wrought have been all in one direction. The conclusion is, that neither savagery nor civilization, as we now see them, can represent the primeval condition of Man. Both of them are the work of time. Both of them are the product of Evolution.

When, however, this conclusion has been reached, we naturally seek for some understanding--some definite conception—of the circumstances and conditions under which development in Man has taken a wrong direction. No similar explanation is required of the origin of civilization. This is the development of Man's powers in the natural direction. Great interest, indeed, attaches to the steps by which knowledge has been increased, and by which invention has been added to invention. But there is no mystery to be encountered here—no dark or distressing problem to be solved. This kind and direction of development is all according to the constitution and course of things. It is in harmony with all the analogies of Creation. Very different is the sense of painful wonder with which we seek an explanation of the wretched condition of Man in many regions of the globe, and, still more, with which we seek the origin of the cause of all the hideous customs which are everywhere prevalent among savage men, and which often, in their ingenuity of evil, and in the sweep of their destructive force, leave it a wonder that the race survives at all.

There are, however, some considerations, and some facts, on which we may very safely advance at least a few steps towards the explanation we desire. Two great causes of change, two great elements of Development or Evolution, have been specified above—namely, the external conditions and the internal nature of Man. Let us look at them for a little separately, in so far as they can be separated at all.[1]

[1] The argument which follows was urged in a former work on "Primeval Man." It has been here re-written and re-considered with reference to various objections and replies

It is certain that external or physical conditions have a very powerful, and sometimes a very rapid, effect both on the body and on the mind of Man. The operation of this law has been seen and noted even in the midst of the most highly civilized communities. There are kinds of labor which have been found to exert a rapid influence in degrading the human frame, and in deteriorating the human character. So marked has been this effect, that it has commanded the attention of Parliaments, and the course of legislation has been turned aside to meet the dangers it involved. Moreover, our experience in this matter has been very various. Different kinds of employment, involving different kinds of unfavorable influence, have each tended to develop its own kind of mischief, and to establish its own type of degradation, The particular conditions which are unfavorable may be infinitely various. The evils which arise out of the abuses of civilized life can never be identical with the evils to which the earlier races of Mankind may have been exposed. But the power of external conditions in modifying the form, and in molding the character of men, is stamped as a general law of universal application.

In connection with this law, the first great fact which calls for our attention is the actual distribution of Mankind in relation to the physical geography of the globe. That distribution is nearly universal. From the earliest times when civilized men began to explore distant regions, they found everywhere other races of men already established. And this has held true down to the latest acquisitions of discovery. When the New World was discovered by Columbus, he found that it must have been a very old world indeed to the human species. Not only every great continent, but, with rare exceptions, even every habitable island has been found peopled by the genus HOMO. The explorers might find, and in many cases did actually find, everything else in Nature different from the country of their birth. Not a beast, or bird, or plant,—not an insect, or a reptile, or a fish, might be the same as those of which they had any previous knowledge. The whole face of Nature might be new and strange—but always with this one solitary exception, that everywhere Man was compelled to recognize himself—represented, indeed, often by people of strange aspect and of strange speech, but by people nevertheless exhibiting all the unmistakable characters of the human race.

In ancient times, before the birth of physical science, this fact might not appear so singular and exceptional as it really is. Before Man had begun to form any definite conceptions as to his own origin, or as to his place in Nature, it was easy to suppose in some vague way that the inhabitants of distant regions were "Aborigines," or as the Greeks called them "Autocthonoi"—that they were somehow native to the soil, and had sprung from it. But this conception belongs essentially to that stage and time when tradition has been lost, and before reasoning has begun. Those who refuse to accept the Jewish Scriptures as in any sense authoritative, must at least recognize them as the records of a very ancient and a very sublime Cosmogony. That Cosmogony rests upon these four leading ideas—first, that the globe has been brought to its present condition through days of change; secondly, that from a state which can only be described as chaos, it came to be divided into sea, and land, and atmosphere; thirdly, that the lower animals were born first,—Man being the last as he is the highest product of Creation; fourthly, that he appeared first at one place only in the world, and that from one pair has all the earth been overspread.

It is remarkable that in this general outline of events, and especially in the unity of Man's origin, the progress of discovery, and those later speculations which have outrun discovery, are in strict accordance with the tradition recorded by the Jewish Prophets. There are, indeed, some, scientific men who think that different races

of men represent different species—or, at least, that if Man be defined as one species, it is a species which has spread from more than one place of origin. But those who hold to this idea are men who stand outside the general current of scientific thought. The tendency of that thought is more and more to demand unity and simplicity in our conception of the methods of creation, and of the order of events through which the birth of species has been brought about. So strong is the tendency, and so intimately connected is it with the intellectual conceptions on which the modern theory of Development has been founded, that Mr. Darwin himself, and Mr. Wallace, who may be said to be joint-author with him of that theory, both lay it down as a fundamental postulate, that each new organic Form has originated, and could only originate, at one place. This doctrine is by no means a necessity of thought, nor is it a necessary consequence of the theory of Development. It rests mainly on the doctrine of chances, and that doctrine may be wholly inapplicable to events which are governed not by accident but by law. It is, however, a postulate of the particular form of that theory which Mr. Darwin has adopted. It is not always easy to reconcile this postulate with the existing distribution over the globe of animal forms. But it is not absolutely inconsistent with the facts so far as we know them; and it is interesting to observe how universally and tacitly it is assumed in all the current explanations of the history of Creation. On this point, therefore, of the unity of Man's origin, those who bow to the authority of the most ancient and the most venerable of traditions, and those who accept the most imposing and the most popular of modern scientific theories, are found standing on common ground, and accepting the same result.

And when we come to consider a very curious subject, namely, the configuration of the habitable continents of the globe, we find that this configuration stands in a very intelligible relation to the dispersion of Mankind from a single center. If, indeed, we could suppose that the earliest condition of our race was a condition of advanced knowledge in the useful arts, there would be no difficulty to solve. The great oceans of the world are now the easiest highways of travel, and, consequently, of dispersion. The art and the science of navigation has made them so. But we cannot imagine that this art or this science was known to our forefathers of a very early age. Various means of crossing narrow waters, from the use of solid logs of wood to the use of the same logs when hollowed out, and so to the use of canoes and boats, were in all probability among the very earliest of human inventions. But not the less would it have been impossible with these inventions to cross the Atlantic, or the Indian Ocean, or even many of the more limited tracts of sea which now separate so many habitable regions. Some other solution must be found for the problem presented by the fact that the earliest navigators who traversed those seas and oceans have always found the lands on the other side already colonized, and in some cases thickly inhabited by races and nations which had made considerable advances in civilization. Yet, this problem presents no serious difficulty in accepting the unity of the human race, when it is regarded in the light of physical geography. The distribution of the larger tracts of land and sea upon our planet is very singular indeed. Attached to the southern Pole there is no mass of land which stretches so far north as to enter the latitudes which are even moderately temperate. In the centre of the Antarctic Circle there is probably a great continent. But it is a continent where volcanic fires burst here and there through surfaces which are bound in perpetual ice. Round that vast Circle roll the continuous waves of an Ocean vexed by furious storms, and laden with the gigantic wrecks of immeasurable fields and cliffs of ice. In the northern hemisphere, round the Arctic Circle, on the contrary, everything is different. There land-masses begin, which stretch southward without a break through all the temperate and through all the torrid zones on both sides of the Equator. Then, again, all these great continents of the globe, as they extend towards the south, become narrower and narrower, and so tend to become more and more widely separated from each other by vast oceanic spaces. Towards the north, on the contrary, all these continents converge, and at one point, Behring's Straits, they approach so near each other that only a space of some forty miles of sea intervenes between them. The result is, that in the northern hemisphere there is either a continued connection by land, or a connection severed only by comparatively narrow channels, between all the great inhabited continents of the world. The consequences of this as bearing on the dispersion of Mankind are obvious at a glance. If, for example, Man may be supposed to have been born in any part of Western or Central Asia, it is easy to see how his earliest migrations might lead him without serious difficulty into every one of the lands in which his children have been actually found. The Indian peninsula was at his feet. A natural bridge, as it were, would enable him to penetrate the Arabian deserts, and would conduct him by the glorious valley of the Nile into the heart of the continent of Africa. Eastwards he had before him the fertile tracts of China, and beyond the narrow passage of Behring's Straits lay that vast continent which, when rediscovered from the West, was called the New World. Again, beyond the southern spurs of the great Asiatic Continent there lay an archipelago of magnificent islands, with comparatively narrow seas between them, and connected by a continuous chain with the continental islands of Australasia. The sea-faring habits which would spring up among an insular population,—especially in an archipelago where every volcanic cone and every coral reef rising above the waves was rich in the products of a bounteous vegetation,—would soon lead to a rapid development of the arts of navigation. When these were once acquired, there is no difficulty in accounting for the gradual dispersion of the human race among the beautiful islands of the Pacific. Across its comparatively peaceful waters it is not improbable that even rude navigators may have made their way at various times to people the western shores of the continent of America.

It is true indeed that the science of geology teaches us that the distribution of sea and land has been immensely various in different epochs of the unmeasured ages which have been occupied in the formation of our existing world. And it may be urged from this that no argument on the methods of dispersion can be based with safety upon that distribution as it now is. There is not much force, however, in this plea. For it is equally true that the evidence afforded by geology is in favor of the very great antiquity of the principal land-masses, and of the great oceanic hollows which now divide them. The antiquity of these is almost certainly much greater than the antiquity of Man. The fauna and the flora of the principal continents indicate them to have been separated since a period in the development, or in the creation of species, long anterior to any probable estimate of the time of Man's appearance. Even if that appearance dates from the Miocene epoch in geology,—which is an extreme supposition,—no great difference in the problem of the dispersion of our species would arise. Since that time indeed it is certain that great subsidences and elevation of land have taken place. But although these changes have greatly altered the outlines of sea and land along the shores of Europe and America, there is no reason to believe that they could have materially affected, either injuriously or otherwise, the earlier migrations of Mankind.

But although the peculiar physical geography of the globe makes it easy to understand how, from a single centre, it must have been quite possible for a creature with the peculiar powers and faculties of Man to distribute himself, as he has actually been found distributed over

every habitable region of the world, it is most important to observe the very adverse conditions to which, in the course of this distribution, particular portions of the human family must have been, and to which we do now find them actually exposed.

The "New World"—the American continent—is that which presents the most uninterrupted stretch of habitable land from the highest northern to the lowest southern latitude. No part of it was without human inhabitants when the civilized children of the Old World first came upon it, and when, from its mountain tops, they first "stared on the Pacific." On its extreme north there was the Eskimo or Inuit race, maintaining human life under conditions of extremest hardship, even amid the perpetual ice of the Polar regions. On the extreme south—at the opposite extremity of the great American continent—there were the inhabitants of Cape Horn and of the island off it, both of which project their desolate rocks into another of the most inhospitable climates of the world. Let us take this case first—because it is a typical one, and because it happens that we have from a master-hand a description of these people, and a suggestion of the questions which they raise. The natives of Tierra del Fuego are one of the most degraded among the races of mankind. How could they be otherwise? "Their country," says Mr. Darwin, "is a broken mass of wild rocks, lofty hills, and useless forests; and these are viewed through mists and endless storms. The habitable land is reduced to the stones of the beach. In search of food they are compelled to wander unceasingly from spot to spot; and so steep is the coast that they can only move about in their wretched canoes." They are habitual cannibals, killing and eating their old women before they kill their dogs, for the sufficient reason, as explained by themselves, "Doggies catch others: old women, no." Of some of these people who came round the *Beagle* in their canoes the same author says: "These were the most wretched and miserable creatures I anywhere beheld. They were quite naked, and even one full-grown woman was absolutely so. It was raining heavily and the fresh water, together with the spray, trickled down her body. In another harbor not far distant, a woman who was suckling a new-born child, came one day alongside the vessel and there remained out of mere curiosity, whilst the sleet fell and thawed on her naked bosom, and on the skin of her naked baby. These poor wretches were stunted in their growth, their hideous faces bedaubed with white paint, their skins filthy and greasy, their hair entangled, their voices discordant, and their gestures violent. Viewing such men, one can hardly make one's self believe that they are fellow-creatures and inhabitants of the same world." Such are the facts, or one aspect of the facts, connected with this people. But there are other facts, or another aspect of the same facts, not less important which we have on the same evidence. Beneath this crust of savagery lay all the perfect attributes of humanity—ready to be developed the moment the unfavorable conditions of Fuegian life were exchanged for conditions which were different. Captain Fitzroy had, in 1830, carried off some of these poor people to England, where they were taught the arts and the habits of civilization. Of one of those who was taken back to his own country in the *Beagle*, Mr. Darwin tells us that "his intellect was good," and of another that he had a "nice disposition."

Let us look now at the questions which the low condition of the Fuegians suggests to Mr. Darwin. "Whilst beholding these savages, one asks whence have they come? What could have tempted, or what change compelled, a tribe of men to leave the fine region of the North, to travel down the Cordillera or backbone of America, to invent and build canoes which are not used by the tribes of Chili, Peru, and Brazil, and then to enter one of the most inhospitable countries within the limits of the globe?"

These questions of Mr. Darwin, it will be observed, assume that Man is not indigenous in Tierra del Fuego. They assume that he has come from elsewhere into that savage country. They assume farther that his access to it has been by land. They assume that the progenitors of the Fuegians who first came there were not skilled navigators like the crew of the *Beagle*, able to traverse the Atlantic or the Pacific in their widest and stormiest expanse. These assumptions are surely safe. But these being accepted, it follows that the ancestors of the Fuegians must have come from the North, and have passed down the whole length, or a great part of the length, of the American continent. In other words, they must have come from regions which are highly favored into regions of extremest rigor. If external circumstances have any influence upon the condition of Man, this great change cannot have been without effect. Accordingly, Mr. Darwin at once, instinctively as it were, connects the utter savagery of the Fuegians with the wretched conditions of their present home. "How little," he says, "can the higher powers of the mind be brought into play! What is there for imagination to picture, for reason to compare, for judgment to decide upon." It is in perfect accordance with this view that on every side of them, and in proportion as we pass northwards from their wretched country, we find that the tribes of South America are less wretched, and better acquainted with the simpler arts. None of the depressing and stupefying conditions which attach to the present home of the Fuegians can be alleged of the regions in which some distant ancestors of the Fuegians must have lived. In Chili, in Peru, in Brazil, in Mexico, there are boundless tracts in which every condition of nature, soil, climate, and productions, are comparatively as favorable to men as they are unfavorable on the desolate shores of Cape Horn and Tierra del Fuego. Yet one or other of these many well-favored regions must have been on the line of march by which the Fuegian shores were reached. One and all of them present attractions which must have induced a long encampment, and must have made them the home of many generations. Why was that march ever resumed in a direction so uninviting and pursued in a destination so desolate and so miserable?

But the moment we come to ask this question in respect to the Fuegians, we find that it is a question which arises equally out of the position and life of many other portions of the human family. The northern extremity of the American continent presents exactly the same problem as the southern. If it is impossible to suppose that Man was first created, or born, or developed in Tierra del Fuego, it is not less impossible to suppose that he had made his first appearance on the frozen shores of Baffin's Bay. Watching at the blow-hole of a seal for many hours in a temperature 75° below the freezing point, is the constant work of the Inuit hunter. And when at last his prey is struck, it is his greatest luxury to feast upon the raw blood and blubber. To civilized man it is hardly possible to conceive a life so wretched, and in some aspects at least so brutal, as the life led by this race during the continual night of the Arctic winter. Not even the most extravagant theorist as regards the possible plurality of human origins can believe that there was a separate Eskimo Adam. Man, therefore, is as certainly an immigrant into the dreary regions round the Pole as he is an immigrant to the desolations of Cape Horn. But the whole conditions of his life there are necessarily determined by the rigors of the climate. They are conditions in which civilization, as it has been here defined, is impossible. And the importance of that definition is singularly apparent in the case of the Eskimo. Although essentially uncivilized, he is not, in the ordinary sense of the word, a savage. Many of the characteristics usually associated with that word are altogether wanting in the Eskimo. They are a gentle, inoffensive, hospitable, and truthful race. They are therefore a conspicuous example of the fallacy of supposing that there is any necessary connection between a backward condition of knowledge in the useful arts, and violent dispositions, or

ferocious and cruel habits. Men are not necessarily savage because they may use flint hatchets, or because they may point their arrows and their spears with bone. Nevertheless, the condition of the Eskimo, although not savage, is almost the type of the merely uncivilized condition of Mankind. It is a condition in which not more than a few families can ever live together, and in which, therefore, large communities cannot be formed. A few simple and some very curious rules of ownership are all that can represent among them the great law-giving instinct which lives in Man. Agriculture cannot be practiced, nor even the pasturing of flocks and herds. Without fuel, beyond the oil which feeds their feeble lamps, or a few stray logs of drift timber, the Eskimo can have no access to the metals, which in such a country could not be reduced from their ores, even if these ores were themselves obtainable. The useful arts are, therefore, strictly limited to the devising and making of canoes and weapons of the chase. There is no domestic animal except the dog, and dogs too, like their masters, must have been brought from elsewhere. These are all conditions which exclude the first elements of what we understand by civilization. But every one of these conditions must have been different with the progenitors of the Eskimo. If they were immigrants into the regions within the Arctic Circle, they must have come from the more temperate regions of the South. They must have been surrounded there by all the natural advantages of which their descendants are now deprived. To what extent these ancestors of the Eskimo may have profited by their very different and more favored position, we cannot know. They may have practiced such simple agriculture as was practiced by the most ancient races which have left their traces in the Swiss Lake dwellings. They may have been nomads, living on their flocks and herds, as the Laplanders and Siberians actually are who in the Old World live in latitudes only a little farther south. They may have been people who, like the ancient but unknown Mound-builders in the Southern and Western States of America, had developed a comparatively high civilization. But one thing is certain, that they must have lived a life wholly different from the life of the Eskimo, and that they must have had completely different habits. Whatever arts the father knew, suited to more genial climates, could not fail to be forgotten by the children, in a country where the practice of them was impossible.

The same question, therefore, which Darwin asks in respect to the inhabitants of the extreme south of the American continent, arises in respect to the inhabitants of its extreme north—What can have induced any people to travel along that continent in a direction more and more inhospitable, and at last to settle in a country where nearly one-half the year is night, and where, even during the short summer, both sea and land are mainly occupied by ice and snow?

But, again, we are reminded that there are other cases of a similar kind. The African continent does not extend so far south as to reach a severe southern latitude. In that continent, accordingly, beyond the frequent occurrence of deserts, there is nothing seriously to impede the migrations of Man from its northern towards its southern extremity; nor is there anything there to subject them when they had reached it to the worst conditions. Accordingly we do not find that the predominant native races of Southern Africa rank low in the scale of humanity. Those among them, however, which are or were the lowest in that scale, were precisely those who occupied the most favorable portion of the country and are known as Bushmen. Of these it is well ascertained that they are not a distinct race, but of kindred origin with the Hottentots, who were by no means so degraded. On the whole, therefore, the question how men could ever have been induced to live where we actually find them, does not press for an answer so much in respect to any part of the continent of Africa, with the exception of a few tribes whose present habitat is exceptionally unfavorable.

There is, however, another case of difficulty in respect to the distribution of Mankind, which in some respects is even more remarkable than the case of the Fuegians, or the case of the Eskimo. We have seen that the great Asiatic continent, though it does not itself extend beyond latitudes which are favorable to human settlement, is practically prolonged through a continuous chain of islands into the regions of Australasia. Every part of those regions was found to be inhabited when they were discovered by civilized man; and it is universally admitted that the natives of Australia, and the natives of Tasmania, are or were (for the Tasmanians are now extinct) among the very lowest of all the families of Man. Now the physical conditions of the great islands of Australasia are in many respects the most remarkable on the surface of the globe. Their peculiar fauna and flora prove them to be of great antiquity as islands in the geological history of the earth. That is to say—their beasts, and their birds, and their vegetation are so widely separate from those of all other regions, that during long ages of the total time which has elapsed since they first appeared above the ocean, they must have been as separate as they are now from all other habitable lands. Their beasts are, indeed, related—closely related—to forms which have existed during certain epochs in many other portions of the earth's surface. But those epochs are so distant, that we are carried back in our search for creatures like them to the times of the Secondary Rocks—to the horizon of the Oolite. Speaking of the poverty and of the extremely isolated character of the Australian Mammalia, Mr. Wallace says: "This class affords us the most certain proofs that no part of the country has been united to the Asiatic continent since the latter part of the Mezozoic period of geology."[2] Of the vast series of creatures which elsewhere have been created, or born, or developed, since that epoch, including all the higher members of the Mammalian Class, not one existed in Australasia until they were introduced by Europeans. Among the grasses there were none which by cultivation could be developed into cereals. Among the beasts there was not one which was capable of domestication. There were no apes or monkeys; no oxen, antelopes, or deer; no elephants, rhinoceroses, or pigs; no cats, wolves or bears; none even of the smaller civits or weasels: no hedgehogs or shrews; no hares, squirrels, or porcupines, or dormice."[3] There was not even a native dog; and the only approach to, or representative of, that wonderful animal, was a low, marsupial beast, which is a mere biting machine, incapable of affection for a master, and incapable even of recognizing the hand that feeds it. In the whole of Australia, with the exception of a few mice, there was not one single mammal which did not belong to this low Marsupial Class, whilst some others belonged to a class still lower in the scale of organization, the class called Monotremata. Strange forms astonished our first explorers, such as the Ornithorynchus and the Echidna—forms which combined features elsewhere widely separated in the animal kingdom—the bills of Birds, the spines of Porcupines, the fur of Otters, and the feet of Moles. Nothing analogous to these relics of an extinct fauna had been known to survive in any other part of the world. Yet in the midst of this strange assemblage of creatures, without any representative of the animals which elsewhere surround him, the familiar form of Man appeared, low, indeed in his condition, but with all the inalienable characteristics of his race. It is true, that everywhere the gap which separates Man from the lower animals is enormous. Nothing bridges, or comes near to bridging it. It is a gap which has been well

[2] "Australasia," by Alfred R. Wallace, p. 51.
[3] "Australasia," by Alfred R. Wallace, p. 51.

called a gulf. But in Australasia the breadth and depth of this gulf is rendered more conspicuous by the association of Man with a series of animals absolutely wanting in those higher members of the Mammalian Class which elsewhere minister to his wants, and the use of which is among the first elements of a civilized condition. Alone everywhere, and separate from other beings, Man is most conspicuously alone in those strange and distant lands where his high organization is in contact with nothing nearer to itself than the low marsupial brain.

To those who connect the origin of Man with the theory of Development or Evolution, in any shape or in any form, these peculiar circumstances respecting the fauna of Australasia indicate beyond all doubt that Man is not there indigenous. They stamp him as an immigrant in those regions—a wanderer from other lands. Nor will this conclusion be less assuredly held by those who believe that in some special sense Man has been created. There is something more than an incongruity in supposing that there was a separate Tasmanian Adam. The belief that the creation of Man has been a special work is not inconsistent with the belief that in the time, and in the circumstances, and in the method of this work, it had a definite relation to the previous course and history of Creation—so that Man did not appear until all these lower animals had been born, which were destined to minister to his necessities, and to afford him the means and opportunities for that kind of development which is peculiarly his own. On the contrary, this doctrine of the previous creation of the lower animals, which is, perhaps, more firmly established on the facts of science than any other respecting the origin of Man, is a doctrine fitting closely into the fundamental conceptions which inspire the belief that Man has been produced by operations as exceptional as their result. And so it is, that when we see men inhabiting lands destitute of all the higher Mammalia, which are elsewhere his servants or companions—destitute even of those productions of the vegetable kingdom, which alone repay the cultivation of the soil, we conclude with certainty that he is there a wanderer from some distant lands, where the work of creation had been carried farther, and where the conditions of surrounding Nature were such as to afford him the conditions of a home.

We see, then, that the question asked by Mr. Darwin, in respect to the Fuegians, is a question arising equally in respect to all the races who inhabit regions of the globe, which from any cause present conditions highly unfavorable to Man. Just as Mr. Darwin asked, what could have induced tribes to travel down the American continent to a climate so rigorous as Cape Horn?—just as we have asked, on the same principle, what could have induced men to travel along the same continent in an opposite direction till they reached and settled within the Arctic Circle?—so now we have to ask, what could have induced men to travel from Asia, or from the rich and splendid islands of the Eastern Archipelago, and to take up their abode in Australasia?

In every one of these cases the change has been greatly for the worse. It has been a change not only involving comparative disadvantages, but positive disabilities—affecting the fundamental elements of civilization, and subjecting those who underwent that change to deteriorating influences of the most powerful kind.

It follows from these considerations as a necessary consequence that the present condition of the Australian, or the recent condition of the Tasmanian, cannot possibly be any trustworthy indication of the condition of their ancestors, when they lived in more favored regions. The same argument applies to them which, as we have seen, applies to the Fuegians and the Eskimo. If all these families of Mankind are the descendants of men, who at some former time inhabited countries wholly different in climate, and in productions, and in all the facilities which these afford for the development of the special faculties of the race, it is in the highest degree improbable that a change of habitat so great should have been without a corresponding effect upon those over whom it passed. Nor is it a matter of doubt or mere speculation that this effect must have been in the highest degree unfavorable. The conclusion, therefore, to which we are led is, that such races as those which inhabit Australasia, are indeed the results of development, or of evolution—but of the development of unfavorable conditions, and of the evolution of the natural effects of these. Instead of assuming them to be the nearest living representative of primeval Man we should be more safe in assuming them to represent the widest departure from that earliest condition of our race which, on the theory of Development, must of necessity have been associated at first with the most highly favorable conditions or external Nature.

DOLBEAR ON THE NATURE AND CONSTITUTION OF MATTER.

A CRITIQUE.

There appeared in "SCIENCE" a series of three papers[1] by Professor A. E. Dolbear which contain such new and somewhat startling ideas on the nature and constitution of matter that an interesting controversy was to be expected. Nearly six months have, however, passed without any objections having been raised to any of the Professor's statements, some of which seem to me quite strange and of rather peculiar mathematics withal. I now, with no little hesitation enter a protest against some of these statements. The subject of the constitution of matter is so intricate, so complicated, beset with so many difficulties on the one hand, while on the other our means of dealing with it are so inadequate, our methods of investigation so imperfect that, as Maxwell says, all we can do is to make hypotheses and see how far our facts and phenomena bear them out. This being so, I believe that whenever a particularly bold hypothesis is made and conclusions are drawn therefrom by anyone without having made a most careful comparison with all the principal phenomena of matter, the humblest student of this fascinating department of physical science has a right to command a most vigorous halt, and to examine whether he who assumes to guide is himself sufficiently acquainted with the intricacies and windings of the road not to lead his followers into the dismal swamps of metaphysical vagaries. I therefore claim for myself that right, lest what I have to say might be construed as too presumptuous.

In my review I shall, in the main, touch upon and discuss the points I desire to examine, in the order in which they occur in the Professor's papers. To begin, then, with the first paper, Section II, I shall devote a little attention to the equation $E' = \epsilon \frac{mv^2}{2}$ which the Professor says expresses the total energy of an atom. It seems an altogether gratuitous assumption to give to the expression for the total energy of an atom the same form that Clausius gives for the total energy of a molecule. In the molecule we have the motion of translation and also the motion or motions of its parts relative to its centre of mass; but of the atom we cannot make the same assertion. Clausius was justified, by mathematical deductions from experimental data, to assume that the total energy of the molecule is proportional to the energy of agitation; but that does by no means justify the assumption that the same form of function also expresses the total energy of the atom, for here all experimental data are wanting. We may, however, reasonably conclude that the form of this function for the atom must differ somewhat from that for the molecule, as the motions of the atom must, of necessity, be much more intricate and complex

[1] "On Some Needed Changes and Additions to Physical Nomenclature," Vol. I., p. 238; "On Matter as a Form of Energy," Vol. II., p. 49, and "On the Amplitude of Vibration of Atoms," Vol. II., p. 146.

than those of the molecule. Granting the correctness of the expression for argument's sake I must confess that I do not understand how the Professor gets the expression $E' - E = \varepsilon$ given under 3, in his "Table of Forms of Energy." If ε in the expression $E' = \varepsilon \frac{m v^2}{2}$ is anything it certainly must be the ratio $\frac{E'}{E}$ where $E = \frac{m v^2}{2}$ is the energy of agitation of an atom. By subtraction we obtain $E' - E = \varepsilon \frac{m v^2}{2} - \frac{m v^2}{2} = \frac{m v^2}{2} (\varepsilon - 1)$ and not ε as the Professor would lead us to believe. While I regard it simply a gratuitous assumption to give the expression for the total energy of an atom, and that for the total energy of a molecule the same form—because we have no experimental evidence whatever to justify us to believe that the conditions of the atom resemble those of the molecule—I believe that the equation $E' = \varepsilon \frac{m v^2}{2}$ in which ε is *internal* energy is utterly incorrect. ε in this expression is not at all analogous to β in $\frac{1}{2} \beta m v^2$ the expression for the total energy of a molecule as given by Maxwell. Here β is the numerical ratio of the total energy to the energy of agitation, an abstract, while ε is internal energy, a concrete. Here let me ask what is energy times energy. The form $E' - E = \varepsilon$ is undoubtedly correct. From this by substitution we get $E' = \frac{m v^2}{2} + \varepsilon$ and not $\varepsilon \frac{m v^2}{2}$.

The statement "Latent heat, specific heat, and specific inductive capacity, are all involved in (that factor?) ε," is certainly not correct. Latent heat is work performed upon some body, and is, according to Clausius, partly internal and partly external. The external work is performed upon surrounding material systems. The internal work is, in general, composed of two parts—one expended upon the molecules in expanding the body from one state of aggregation to another, the other part is expended upon the parts of the molecule. It is only this last portion which can affect the atom as such, and which can in any way be involved in ε. Similarly we find that specific heat is also work performed, and that, too, of a complex nature. Specific inductive capacity seems to me to belong to an altogether different class of phenomena.

In regard to the ether the Professor makes some very curious statements. He says that he knows nothing of the specific properties of the ether, yet in the same sentence is the statement "ether is not matter," as if this were a generally accepted view. If the ether is not matter, what is it? There are two ways of looking at matter—the subjective or metaphysical, and the objective or physical. Metaphysically defined matter is anything which has extension or occupies space. For the physical definition I quote Maxwell[2]: "Hence, as we have said, we are acquainted with matter only as that which may have energy communicated to it from other matter, and which may, in its turn, communicate energy to other matter." Again, he says: "Energy cannot exist except in connection with matter." Whether, then, we accept the metaphysician's definition or the physicist's, we must regard ether as matter; for it certainly has extension and occupies space, and it certainly receives from other matter, transmits and imparts to other matter energy. That Maxwell regarded ether as matter, appears from the following quotation, taken from the same work and page as the preceding: "Hence, . . . we conclude that the *matter* which transmits light is disseminated through the whole of the visible universe." The italics are mine. Professor Dolbear, furthermore, tacitly assumes ether to have mass, as will appear hereafter.

Again, the Professor says: "Furthermore, as atoms differ in mass so will their rates of vibration differ when they possess the same absolute amount of energy. Velocity, in this case, will be equal to amplitude $a\ b$, the space point c passes over during one vibration. If m and m' be two atoms of different masses having equal energy of vibration, then $E = \frac{m v^2}{2} = \frac{m' v'^2}{2}$ and $\frac{m}{m'} = \frac{v'^2}{v^2}$ that is the square of their velocities is inversely as their masses, so that wave-length in the ether will vary as the mass of the atom." This is certainly very curious logic and mathematics. The statement may be true, and the investigations of Lecoq de Boisbaudran even furnish some evidence in its favor, but the mathematical proof offered by the Professor does not justify any such conclusion. v and v' are, according to his own statement, amplitudes of vibration; when, then, the atoms of different masses have equal energy, the proportion $\frac{m}{m'} = \frac{v'^2}{v^2}$ simply proves that the squares of the amplitudes of vibration are inversely as the masses. In what manner the rate of vibration and wave-length in ether follows from this relation of mass to amplitude the Professor does not make clear. In order to make the above conclusion of Professor Dolbear correct, we must have the further condition, $\frac{v'^2}{v^2} = \frac{n'}{n}$ where n and n' are the relative number of vibrations of m and m' in equal times. One of the most fundamental equations of motion is unquestionably $v = \frac{s}{t}$. Hence, as the amplitude $a\ b$ is a space passed over in a given time, we can make it equal to v only by making t unity. Similarly we can make the amplitude of m' equal to v' only by making t unity. If now we wish to compare the velocities and masses of the two atoms we can certainly not use different units of time to determine those velocities; and we get, according to the Professor's statement, the self-contradictory result that two atoms, which make each one vibration in equal times yet have different rates of vibration. To make the problem more general let us take two atoms of masses m and m'. Let them make respectively n and n' vibrations of amplitudes, a and a' in unit of time. The time of one vibration of m will be $\frac{1}{n}$ and of m', $\frac{1}{n'}$. Substituting these values successively for t, and a and a' successively for s in the equation of motion, we have

$$v = \frac{a}{\frac{1}{n}} = an \text{ and } v' = \frac{a'}{\frac{1}{n'}} = a' n' \text{ combining } \frac{v}{v'} = \frac{an}{a' n'},$$

or the velocities are proportional to the products of the amplitudes by the number of vibrations in unit time. Combining this with the Professor's proportion we have $\frac{m}{m'} = \frac{a'^2 n'^2}{a^2 n^2}$.

To obtain from this the relation $\frac{m}{m'} = \frac{\lambda}{\lambda'}$, λ and λ' being wave-lengths, we must fulfil the condition $\frac{a'^2 n'^2}{a^2 n^2} = \frac{n'}{n}$ or $\frac{n}{n'} = \frac{a'^2}{a^2}$. If, then, two atoms of the masses m and m' have equal energy, and the relation $\frac{n}{n'} = \frac{a'^2}{a^2}$ holds n and n', being the respective number of vibrations in unit time, and a and a' corresponding amplitudes, the relation $\frac{\lambda}{\lambda'} = \frac{m}{m'}$ in which λ and λ' are wave-lengths will follow. For we will then have, as above shown, $\frac{m}{m'} = \frac{n'}{n}$. We also have $\lambda = \frac{v}{n}$ and $\lambda' = \frac{v}{n'}$. From these we obtain $\frac{\lambda}{\lambda'} = \frac{n'}{n}$ and, hence, $\frac{m}{m} = \frac{\lambda}{\lambda'}$.

[2] "Matter and Motion," p. 93.

Whether or not the relation $\frac{n}{n'} = \frac{a'^2}{a^2}$ holds in any particular case can, it would seem, be determined only by experiment. So, too, the fact of the equal absolute energy of vibration of two atoms. Our experimental methods are, however, as yet far from competent to deal with either question, and until they are it is certainly premature to build up speculative hypotheses.

Every student of molecular science knows how great is the temptation to build hypotheses which are to account for all the physical and chemical relations of matter. We can read between the lines of nearly all our recent writers in this department of science their secret belief that chemical phenomena are probably but a complex phase of mechanical phenomena, and that all matter is probably one. Nor are facts justifying such views altogether wanting. Probably no chemist would be bold enough to say in how far such phenomena as, for instance, the solution of ammonia, carbon dioxide, and many other gases in water are of purely chemical and how far of purely physical nature. There are many other phenomena in which similar difficulty would be felt. The phenomena of adhesion and cohesion are such that it does not require a very great stretch of the imagination to suppose that they may be but different phases of what we call chemical union. But to pass from such general and indefinite speculations to suppositions in regard to the mechanical conditions which will account for all these phenomena and all the properties of matter upon purely mechanical principles is a long and, indeed, a bold stride. As the temptation to make this attempt is great, so ought our caution to be great in making the attempt. Professor Dolbear's immediate predecessor in this attempt is Professor Norton. His hypothesis of two atmospheres, one attractive, the other repellant, surrounding each atom, is too artificial, and in being in opposition to the "Kinetic Theory of Gases," is probably too much out of sympathy with the tendency of modern thought to make many converts. Not so, however, with Professor Dolbear's speculations. Their great fundamental simplicity, as well as their thoroughly Kinetic nature, make them dangerous to healthy progress in molecular science unless they can maintain their right of being by accounting for at least the chief and fundamental phenomena of matter. I shall now attempt to apply the touch-stone to them. In Section IV. of his first paper Professor Dolbear advances an hypothesis of chemical union founded on the analogy to a vibrating body which, as is well known by reducing the average density of the atmosphere, causes light bodies to cling to it by atmospheric pressure. We are told that precisely the same conditions exist in the ether near a vibrating atom; that the average density of the surrounding ether is lessened, and that by extraneous pressure another atom vibrating synchronously with the first would attach itself thereto, and the molecule would be formed, etc., etc. I would like to ask how Prof. Dolbear can consistently speak of the density of ether, which, he says, is not matter. Now, in this idea of density there is implicitly the idea of mass, for density, as every one knows, is the mass or amount of matter in unit volume. But, disregarding this inconsistency, it is certainly very bold induction, if induction it can be called, to attribute chemical union to a lessening of density of ether due to atomic vibrations because a vibrating tuning-fork attracts light bodies when brought sufficiently near. In the professor's hypothesis the atoms (vortex-rings) vibrate about a circle as figure of equilibrium, and consequently have four points of maximum displacement or minimum density of the ether. As a consequence of this, each atom must attract other atoms capable of attaching themselves to it at four points. To judge from his diagrams, the Professor believes that atoms unite only in two-dimensional space, *i.e.*, that the centres of all the atoms lie in the same plane. Such a distribution of the atoms would render any closed structure such as a saturated molecule an impossibility, for the peripheral atoms would constantly attract further atoms as long as they vibrate, and other atoms vibrating synchronically with them are present. If, on the other hand, the atoms are arranged in tri-dimensional space, having their centres in planes, say, at right angles to one another, the simplest molecule and the only really stable one would have to contain six atoms whose planes of rotation form the faces of a cube. A further possible supposition is that the atoms would arrange themselves in parallel planes with their centres in a line at right angles to these planes. The first of these suppositions, as already indicated, would not allow the formation of saturated molecules, and it would seem that all chemical union, as we know it, could not exist, for it would evidently be altogether a matter of chance how atoms grouped themselves in regard to numbers, so that we could not always obtain like results of union under precisely like conditions. The second supposition is also inconsistent with chemical facts, for we have molecules of two, three, four and five atoms, as well as others containing hundreds. The third supposition is also untenable, for from Helmholtz's mathematical investigations and Tait's experiments we know that two vortex-rings, when they move axially in the same direction alternately, pass through each other one expanding, the other contracting, while when moving axially in opposite directions they both expand moving slower and slower, but never meet. This is, according to Tait, about all we know experimentally or mathematically in regard to the action of one vortex ring upon another. It is certainly a little strange that Prof. Dolbear, in framing his hypothesis, completely ignores these known facts, and relies on a far-fetched analogy. Serious as are these difficulties, they are by no means the most serious. If experimental evidence is worth anything, we must believe that elementary molecules, with a few exceptions, consist of two atoms, which are, as far as we can judge, exactly alike. Furthermore, we find that in all chemical reactions we can deal with nothing less than the molecule; we know and can deal with the atom only as a part of a molecule, and not as an independent existence. When chemical union takes place between two elements, there is simply an interchange of atoms between the molecules. The difference between the molecules of an element, and those of a compound, is simply this, that the atoms of elementary molecules are all alike, while those of a compound molecule are unlike. I repeat all these fundamental and well-known chemical facts and deductions, to show how singularly inadequate Prof. Dolbear's hypothesis is to account for even the most simple chemical facts. According to his hypothesis, the atoms whose rates of vibration are most exactly alike, must form the most stable molecules. Consequently, the atoms of an element must cling more firmly together than can those of two different elements, and chemical union between the elements becomes impossible. Did the atoms of elements exist as individuals, and not as parts of molecules simply, synchronism of vibrations might be a possible supposition to account for chemical union; but as the case stands, we must reject any such hypothesis as precluding all combination between atoms of different elements. Setting aside even this difficulty, how are we to account by synchronous vibrations for the liberation of energy in the form of heat and light, which accompanies most chemical unions. These forms of energy are, according to the Professor himself, altogether due to vibrations of the atoms and these same vibrations cause the union. Now, how can they both cause the union and be produced by it? Does this not look a little like *perpetuum mobile?* Had the Professor tried to explain adhesion and cohesion by molecular vibration his position would undoubtedly be much stronger. We know that molecules are complex and that there must be motion of their parts relative to the centre of mass of

the molecule. As there is no good reason for supposing the motions of these parts or atoms to be rather in one plane than another, we must admit the possibility of motion in all planes. The vibrations would, however, probably be in three planes at right angles to one another in all molecules of more than three atoms; and would, consequently, have six points of maximum displacement and minimum density of the surrounding ether. Molecules of two and three atoms might possibly vibrate in two or only one plane. As molecules are not vortex-rings, though possibly groups of vortex-rings, the analogy to a vibrating tuning fork becomes much closer than in the case of a vibrating vortex-ring, and we are much more justified in trying to make application of the hypothesis. Prof. Dolbear's analogy thus modified can, I think, be made a very fair working hypothesis to explain adhesion, cohesion and even crystallization. The phenomena of surface tension of liquids and capillary action find a reasonably fair explanation upon this hypothesis, and possibly also those of osmosis, dialysis and occlusion. But even here such an hypothesis meets with many difficulties and we must exercise extreme caution, and must gather further experimental evidence before committing ourselves to its acceptance.

In his second paper the Professor tells us that the vortex-ring theory assumes that matter is a *form of energy*, etc. Never having been so fortunate as to have had access to Sir William Thomson's original memoir, I know his celebrated hypothesis only through interpretations of others. From these interpretations I have always supposed that this hypothesis assumes that all matter is essentially one; and that the elements, as we know them, are portions of this common matter imbued with vortex-motion, thus forming vortex-rings variously knotted, whose energy is non-interchangeable with other forms of energy provided the vortex-rings are formed and exist in a perfect or frictionless fluid. If the fluid is not quite perfect, not quite frictionless, the vortex-rings must gradually be destroyed and their energy must be transformed. The uniform material substratum, if I understand the hypothesis correctly, consists of smaller and simpler vortex-rings which are also the particles or atoms of the ether. If, then, I comprehend the positions, the non-transformability of the energy of the vortex atoms and also their permanence, *i. e.* the persistence of our elements depend upon the perfect fluidity of the ether. Whether the ether is perfectly frictionless or not science is, I think, hardly ready to answer. To call "*matter a form of energy* not interchangeable with other variable forms" is, under the circumstances and from the meaning of the terms employed, to take extraordinary liberties with language. Physically regarded, energy is, to strip the term of all technicalities, matter in motion. Then Professor Dolbear's statement becomes matter, is a form of matter in motion, which is hardly intelligible. Again we are told 'The energy of a mass of matter varies as the square of the velocities, but the *properties* of the mass vary with the form of the energy, that is to say the physical properties of a heated body are not identical with those of the same body when it is cool, but possesses the same amount of energy in free path motion." Exactly what this sentence means is, I must confess, beyond my comprehension. One thing, however, seems certain, that it expresses an idea directly opposed to the "Mechanical Theory of Heat" and the "Kinetic Theory of Gases" in the statement that a cool body "possesses the same amount of energy in free path motion" as the same body when heated. If this be so, what becomes of $\frac{v\,p}{\tau} = \frac{v'\,p'}{\tau'}$ for gases, and what of the "Thermo-dynamic Scale of Temperature."

In regard to the assumption $\frac{mv^2}{2}$ = atomic weight and the calculations based thereon, I will merely remark that if the groups having the same m or those having the same v showed any family likeness or any gradual variation of properties as do Mendelejeff's periods and groups, then they would be worthy of consideration. As it is, however, they seem mere jugglery with figures. That the atoms of the elements have a "common form differing arithmetically from each other in size and velocity" is utterly inconsistent with the well-known facts and phenomena of quantivalence or valency of atoms. There would have to be two forms at least one for artiad, and one for perissad atoms. I think for the present, at least, we must reject this idea of simplicity and still follow Sir William Thomson.

In the third paper we read, "There is now sufficient evidence for the belief that the Kinetic energy of atoms and molecules consists of two parts, one of which is the energy of translation or free path, the other of a change of form due to vibrations of the parts of the atom or molecule toward or away from its centre of mass. The pressure of a gas is immediately due to the former while the temperature depends solely upon the latter." To the first sentence of this quotation I object, because atoms and molecules are treated as if similar, for which assumption we have no evidence. The second sentence contains the very strange idea that the temperature of a gas is due only to the internal energy of the molecule. Maxwell in his "Theory of Heat" Chap. XXII, under "Specific Heat at Constant Volume" says: "Since the product pv is proportional to the absolute temperature, the energy is proportional to the temperature." By energy Maxwell here means, as appears from the context, what Prof. Dolbear would call total energy. From this it appears that Prof. Dolbear's statement can hardly be correct. If we remember that Maxwell speaks of molecules and Prof. Dolbear of atoms the latter's statement becomes still more doubtful. The assumption that "these two forms of energy must indeed be equal to each other in a gas under uniform conditions," upon which all the Professor's calculations in his third paper are based, can easily be disproved. The Kinetic energy of agitation of a molecule is $\frac{1}{2}\ mv^2$ and the (total) energy is "$\frac{1}{2}\ \beta\ mv^2$ where β is a factor always greater than unity and probably equal to 1.634 for air and several of the more perfect gases." Hence the internal energy is $\frac{1}{2}$ (.634 mv^2.) This, of course, invalidates all the Professor's calculations.

Having extended my remarks far beyond what I originally intended, I shall touch upon only one more point, though I find various other difficulties in the Professor's speculations. The last paragraph of the third paper begins: "As at absolute zero each atom is quite independent of every other atom, that is, matter has not a molecular structure, etc." Now, I would like to ask the Professor how he knows this. Such a state of affairs would indeed make the absolute zero a more than singular point in the curve of the properties of matter.

BUFFALO, N. Y., *April* 20, 1881. WM. H. DOPP.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. No notice is taken of anonymous communications.*]

INTRA-MERCURIAL PLANETS.

To the Editor of "SCIENCE:"

I wish to say that in the sketch given to "SCIENCE," No. 35, p. 95, the position of Professor Swift's Vulcans is very nearly as they were put down by Professor Swift himself on a map that now hangs in my room at the Naval Observatory.

As to negative evidence there is something to be said on both sides of the question. When extraordinary discoveries are reported they are to be severely examined and carefully criticised. If the observations on which

the discoveries rest are conflicting among themselves, and if the probability of such discoveries is rendered small by long and careful series of independent observations, we are justified in waiting for further evidence before we accept the alleged discoveries as true. The ways in which an observer may be deceived are numerous. In 1878 an astronomer wrote me that he had discovered a satellite of Venus that revolved around the planet in thirty seconds. I expressed some doubt and advised him to examine his telescope and the eye pieces. He did so and was candid enough to inform me that the satellite he had discovered was nothing but a "ghost."

If any astronomer who is familar with astronomical observations and their discussion, will examine the reports on the Vulcans supposed to have been discovered during the eclipse of 1878, and will notice how the reports were changed from time to time, he will find good reasons for doubt. Certainly this matter is not to be settled by assertion. If there are Vulcans of the fourth and fifth magnitudes which attain an angular distance of from three to seven degrees from the sun, they ought to be found easily. A. HALL.

Washington, April 25, 1881.

THE SOLAR PARALLAX.

To the Editor of "SCIENCE":

From the American photographs of the Transit of Venus, as presented in part the first of "Observations of the Transit of Venus, December 8, 9, 1874, Made and Reduced Under the Direction of the Commission Created by Congress," I have obtained, for the value of the solar parallax, $8.883'' \pm 0.034''$ corresponding to a distance between the centres of the sun and the earth equal to 92,028,000 miles. D. P. TODD.

WASHINGTON, *April* 26, 1881.

ASTRONOMY.

MOUNT ETNA OBSESVATORY.—The *Memoirs* of the Italian Spectroscope Society contains an illustration of the Observatory of Mount Etna, showing that work upon the building has progressed as rapidly as could have been expected, when we consider the difficulties to be overcome in the transportation of materials, etc. Every effort is being made to finish the Observatory by 1882, and provide it with a director and staff both of astronomers and meteorologists. W. C. W.

Messrs. Houzeau and Lancaster, the Director and Librarian of the Bruxelles Observatory, are performing an extremely valuable service to astronomers by the preparation of a general bibliography of Astronomy. Two volumes have thus far appeared, the second of which is just published, and is devoted to memoirs which have appeared in scientific periodicals, and in the publications of the various academies. Four topics are included in this volume, Spherical Astronomy, Theoretical Astronomy, Celestial Mechanics, and Physical Astronomy. The only thing which even approximates the completeness of the present work, is the catalogue of the library of the Poulkova Observatory, a new edition of which has been in course of preparation for several years past. The Bruxelles work, however, has the advantage of being a general bibliography, and not limited to the contents of any one library, however extensive. O. S.

MICROSCOPICAL NOTES.

At our suggestion, Mr. Lockwood, of New York City, who has already devoted considerable attention to the application of Photography to the various branches of science, now proposes to make arrangements for photographing Microscopical Preparations.

The objects will be enlarged by very perfect and powerful objectives, and photographed while thus enlarged.

Those possessing microscopes will at once notice the great advantage to be secured by such an arrangement. Few possess the skill to produce a drawing from a microscopic object, while the amount of detail involved in sketching anatomical preparations, can be mastered by few who are not professed artists.

When Mr. Lockwood's arrangements are complete a microscopist, for a moderate amount, will be enabled to have a perfect copy of any microscopic preparation, and as many duplicate as he requires to circulate among specialists, or his friends. Should he desire to publish the result of his researches, Mr. Lockwood can then photograph the object directly on the wood block, ready for the hand of the engraver.

The chief value of the use of Photography in such a case lies in the fact that such drawings, being prepared by the hand of nature, their integrity cannot be impeached, and that any charge of exaggeration or error cannot be maintained.

When Mr. Lockwood's arrangements are complete we will announce the fact in our microscopical column, but in the interval would be glad to hear from those who are likely to avail themselves of these facilities for promoting microscopical research.

NOTES.

Les Mondes proposes to apply the photophone to the study of the *aurora borealis*.

ON THE GALVANIC POLARIZATION PRODUCED BY METALLIC DEPOSITS.—The polarization of copper, employed as negative electrode in a solution of sulphate of zinc, is never null, as Lipmann believes, in cases where the solution contains traces of a salt of copper, and that the deposit of zinc is exceedingly slight and invisible. On the contrary, it has a value which may differ much, and which is so much the greater the smaller the quantity of a copper-salt contained in the solution, and the less the time which has passed from the moment when the polarizing current was interrupted.—D. MACALUSO.

ON THE ELECTROMOTIVE FORCE OF VOLTAIC ARC.—When an electric flux is established between two conductors of the same nature by means of a gaseous medium, which is commonly the vapor thrown off by their substance, the inequality of temperature of those portions of the conductors which are contiguous to such a medium appears to be a general fact. It seems not less probable that the extremity by which the positive electricity arrives, possesses the higher temperature. This is observed in a remarkable degree in the production of the voltaic arc between two carbons, by means of a current of constant direction. The idea of ascribing to this phenomenon a thermo-electric origin is not novel. According to the application of the principle of the equivalence of heat to electric phenomena, an electromotive force acting in the inverse direction of the current, corresponds to a disengagement of heat at the point of junction of two heterogeneous substances.—M. F. P. LE ROUX.

MAGNETIC ACTION UPON THE FLUORESCENT LIGHT PRODUCED BY THE NEGATIVE DISCHARGE IN AN EXHAUSTED SPACE.—If we take a well-exhausted cylindrical tube, with rectilinear electrodes placed in its axis, the fluorescent light formed by the cathodic rays consists, as is well known, of a green cylinder bounded by a circle. This circle undergoes transpositions if a magnet is allowed to act upon the discharge. It can be shown that these, whether simple or complicated cases, may be explained by the following hypothesis:—The cathodic rays, emanating from the negative electrode, pass on in a straight direction, and the current moves from the anode to the sides of the cathodic space, and from thence to the negative electrode. The magnet acts upon these currents according to Ampère's rule.—K. DOMALIP.

BOOKS RECEIVED.

COMPENDIUM OF MICROSCOPICAL TECHNOLOGY; A guide to Physicians and Students in the use of the Microscope, and in the preparation of Histological and Pathological specimens. By CARL SEILER, M. D. Published by D. G. Brinton, Philadelphia, 1881.

The author of this work has a high reputation for preparing mounted specimens for Microscopical study, and therein gives short and clear descriptions of his own methods, which have given such satisfactory results. The reader is, therefore, not perplexed by being instructed in the various methods suggested by many authorities, but a clear line of conduct is indicated for him by Dr. Seiler, which may be relied on as being satisfactory.

The work is written for medical students, and for that reason the usual subject matter found in Manuals of Microscopy is altogether omitted, neither are descriptions given of tissues, and the student is referred for histological details to works devoted to histology.

Without intending to cast any reflection on the body of the work, we are inclined to consider the appendix the most valuable part of Dr. Seiler's book. In it the author presents a short, concise, and, at the same time, comprehensive classification of the more common tumors and other neoplasms in tabular form; these, indeed, will be welcome to the student of pathological histology. The author claims to have exercised great care in its compilation, and to have introduced all the accepted modern views on the subject, so as to bring it up to the standard of the present time.

POPULAR LECTURES ON SCIENTIFIC SUBJECTS. By H. HELMHOLTZ, Professor of Physics in the University of Berlin. Translated by E. ATKINSON, Ph. D., F. C. S. Second Series. D. Appleton & Co. New York, 1881.

The present volume presents a series of addresses and lectures delivered by Professor Helmholtz during a period of six years, from 1871 to 1877. The contents show that the following subjects are treated:

1. An address delivered before the Leibnitz meeting of the Academy of Sciences, 1870. In memory of Gustav Magnus.

2. A lecture on the Origin and Significance of Geometrical Axioms, delivered at Heidelberg, 1870.

3. The substance of a series of lectures on the relation of optics to painting, delivered at Cologne, Berlin and Bonn.

4. Lecture on the Origin of the Planetary System, delivered in 1871.

5. An address delivered in 1877, on the Anniversary of the foundation of the Institute for the Education of Army Surgeons: or, Thought in Medicine.

Perhaps the only popular paper in the series is that "On the Origin of the Planetary System," in which the various hypotheses connected with the subject are explained in simple and familiar language. Professor Helmholtz appears to have handled this subject in a manner which must have been a source of delight to a mixed audience. Touching on extinct suns he explained that a time would arrive when our own sun would cease to develop the heat which is a source of vitality to this earth. But he explained that 17,000,000 of years would lapse before this "intensity of sunshine, would be diminished, and that circumstances may even prolong this period."

Looking forward to such a period when our sun shall be extinguished, Professor Holmholtz observes that considering the wonderful adaptability to the conditions of life which all organisms possess, who knows to what degree of perfection our posterity will have developed in 17,000,000 of years, and whether our fossilized bones will not seem to them as monstrous as those of *Ichthyosaurus* now do; and whether they, adjusted for a more sensitive state of equilibrium, will not consider the extremes of temperature, within which we now exist, to be just as violent and destructive as those of the older geological times appear to us? Yea, even if sun and earth should solidify and become motionless, who could say what new worlds would not be ready to develop life? Meteoric stones sometimes contain hydro-carbons; the light of the heads of comets exhibits a spectrum which is most like that of the electrical light in gases containing hydrogen and carbon. But carbon is the element, which is characteristic of organic compounds, from which living bodies are built up. Who knows whether these bodies, which everywhere swarm through space, do not scatter germs of life, wherever there is a new world, which has become capable of giving place to organic bodies? And this life we might perhaps consider as allied to ours in its primitive germ, however different might be the form which it would assume in adapting itself to its new dwelling place.

Probably the lectures "On the Relation of Optics to Painting" and the address "On Thought in Medicine" are the most valuable productions of Professor Helmholtz to be found in this volume, and as space for their proper examination cannot be used in this notice, references will be again made to them on another occasion.

This work should find a place in every library of standard works of Literature.

A MOST successful experiment in theatre illumination was tried on March 30 and 31, at the Athenæum of the Rue des Martyrs, Paris, with the Werdermann incandescent light. The peculiarity of it is that it can be graduated at will for scenic effects, either by introducing resistance coils or varying the velocity of the Gramme machine.

EFFECT OF TEMPERATURE UPON THE ELECTRICAL RESISTANCE OF SELENIUM.—Mr. Shelford Bidwell, in the *Philosophical Magazine* for April, gives an account of some experiments made on the above subject. He says: "The room being 14° Centigrade, a selenium cell was immersed in turpentine at 8° C. There was a great and sudden fall in the resistance. The temperature was then gradually raised. In passing from 8° to 24° the resistance steadily increased; from 24° upwards it rapidly diminished. For this cell, therefore, the resistance is greatest at 24° C. Five other cells were afterwards submitted to the same operation, and their resistance was found to be greatest at temperatures of 23°, 14°, 30°, 25°, and 22° respectively."

ELECTRIC TRANSMISSION OF FORCE FOR WORKING CRANES.—According to E. Hospitalier, the use of hydraulic pressure for the transmission of the power required in working cranes in docks, involves a loss which, in some cases, may reach 88 per cent. This evil is entirely obviated, in addition to a great simplification of the entire plant, by means of electric transmission of power, which enables the original steam power to be fully utilised even when the crane is raising much less than its maximum load. If we reduce the loading of a crane the electro-magnetic machine which drives it will have less work to do, and will revolve more rapidly, and the stronger counter-currents thus produced will react upon the dynamo-electric machine in such a manner that there is a less current produced, and a less demand is made upon the steam-power. The only question is, how the current is to be divided into several unequal branches capable of being varied in strength at any moment.—*La Lumière Electrique.*

ON THE STATIONARY ELECTRIC CURRENT IN CONDUCTIVE SURFACES, AND ON THE GALVANIC RESISTANCE OF PSILOMELAN.—Hugo Meyer, in the first portion of this memoir, discusses the ramification of the current, and the calculation of the resistance of flat plates. The experimental results agree with calculation. In the second part the author's experimental results agree with calculation. In the second part the author examines the resistance of thin plates of psilomelan, and obtains results antagonistic to those of Braun, who found the resistance decrease under the influence of an induction current.